

First analysis of eight Algol-type systems: V537 And, GS Boo, AM CrB, V1298 Her, EL Lyn, FW Per, RU Tri, and WW Tri

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Abstract

Analyzing available photometry from the Super WASP and other databases, we performed the very first light curve analysis of eight eclipsing binary systems V537 And, GS Boo, AM CrB, V1298 Her, EL Lyn, FW Per, RU Tri, and WW Tri. All of these systems were found to be detached ones of Algol-type, having the orbital periods of the order of days. 722 new times of minima for these binaries were derived and presented, trying to identify the period variations caused by the third bodies in these systems.

Key words: stars: binaries: eclipsing, stars: fundamental parameters
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1 Introduction

The eclipsing binaries provide us with an excellent method how to derive the basic physical properties of the two eclipsing components (their radii, masses, temperatures). Moreover, they can also serve as independent distance indicators, one can study the dynamical evolution of the orbits, test the stellar structure models, or discover additional components in these systems (see e.g. Guinan & Engle 2006). Due to these reasons and availability of the photometric observations for some of these systems, we decided to carry out the first analysis for a few eclipsing binaries which were never been studied before.

The analysis of the light curves (hereafter LC) became almost a routine task thanks to the programs like PHOEBE (Prša & Zwitter, 2005). Also the pho-

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photometric data are very easy to be obtained due to long-term monitoring surveys covering a large fraction of the sky – like NSVS (Woźniak et al., 2004), ASAS (Pojmanski, 2002), Super WASP (Pollacco et al., 2006), and others.

2 Analysis

The target selection for this paper was rather straightforward. We have chosen only these systems, which are known to be eclipsing variables, their orbital period is known, has never been analysed before and have enough photometric data points for an analysis. Thanks to the good time coverage provided by the Super WASP survey we used this database for the whole analysis. All of the analysed systems are the northern-hemisphere stars ($DE > 20^\circ$) of moderate brightness ($9.5 \text{ mag} < V < 13 \text{ mag}$) and with the orbital periods ranging from 0.6 to 3.3 days.

For the light curve analysis the PHOEBE program (Prša & Zwitter, 2005) was used, which is based on the algorithm by Wilson & Devinney (1971). None of the selected stars was ever observed spectroscopically, hence some of the parameters have to be fixed during the light curve solution. At first, the "Detached binary" mode (in Wilson & Devinney mode 2) was assumed for computing. The value of the mass ratio q was set to 1. The limb-darkening coefficients were interpolated from van Hamme's tables (see van Hamme 1993), the linear cosine law was used. The values of the gravity brightening and bolometric albedo coefficients were set at their suggested values for convective or radiative atmospheres (see Lucy 1968). Therefore, the quantities which could be directly calculated from the light curve are the following: the relative luminosities L_i , the temperature of the secondary T_2 , the inclination i , and the Kopal's modified potentials Ω_1 and Ω_2 . The synchronicity parameters F_1 and F_2 were also fixed at values of 1. The value of the third light L_3 was also computed if a non-negligible value resulted from the fitting process. And finally, the linear ephemerides were calculated using the available minima times for a particular system.

With the final LC analysis, we also derived many times of minima for a particular system, using a method presented in Zasche et al. (2014). The template of the LC is used to fit the photometric data from the Super WASP as well as from other surveys, resulting in a set of minima times, which can be used for a subsequent period analysis. The already published observations were also used for the analysis, mostly taken from the ($O - C$) gateway¹ (Paschke & Brát, 2006).

¹ <http://var.astro.cz/ocgate>

3 The individual systems

3.1 *V537 And*

The system V537 And (= GSC 02814-01959, V=11.2 mag) is relatively neglected eclipsing binary of Algol-type. It was first mentioned by Khruslov (2008), who analysed the NSVS photometry and found an orbital period of about 0.9 days and relatively deep eclipses of about 0.3 mag. However, since then no detailed analysis of this target was performed, only a few times of minima were published to better constrain the orbital period (Hoňková et al., 2013).

We extracted the Super WASP photometry of the star for the LC analysis. However, only a small fraction of the data points were used for the LC modelling (these ones with better precision and obtained during a shorter time span). For the light curve fitting process one of the most crucial parameters is the value of the primary temperature T_1 , which is kept fixed during the whole fitting. Due to the fact that the star was included into the Tycho survey onboard the Hipparcos satellite, as well as observed during the 2MASS and NOMAD surveys, Pickles & Depagne (2010) used all of these data to roughly estimate the spectral type of the system. This resulted in G0V, which is the only available spectral estimation of V537 And. Therefore, we fixed the primary temperature at a value of $T_1 = 5900$ K, in agreement with its spectral type (see e.g. Harmanec 1988). The PHOEBE program was used and the final fit is presented in Fig.1. As one can see, the magnitudes during both maxima are different, hence also the hypothesis of a photospheric spot on the surface of the primary component was used. The final LC parameters are presented in Table 1. The secondary component is a bit cooler and smaller, while no third light was detected.

We also used the LC template for deriving the times of minima from the available photometry (Super WASP and NSVS). All of these data points are stored in the Table 12. In total, 137 new times of minima were derived. Together with four already published minima, these observations can tell us something about the long-term evolution of the orbit (see Fig. 2). However, no additional variation is visible on these data points (no third-body modulation of the orbit), which is in agreement with no third light detected from the LC solution. However, one can speculate about the very first and the very last data points plotted, and maybe a parabolic fit would give us a better solution (which can be attributed to the mass transfer between the components). However, a longer time span is needed for this to be definitely solved. The linear ephemerides as resulted from the analysis of minima times led to the values JD_0 and P as presented in Table 1.

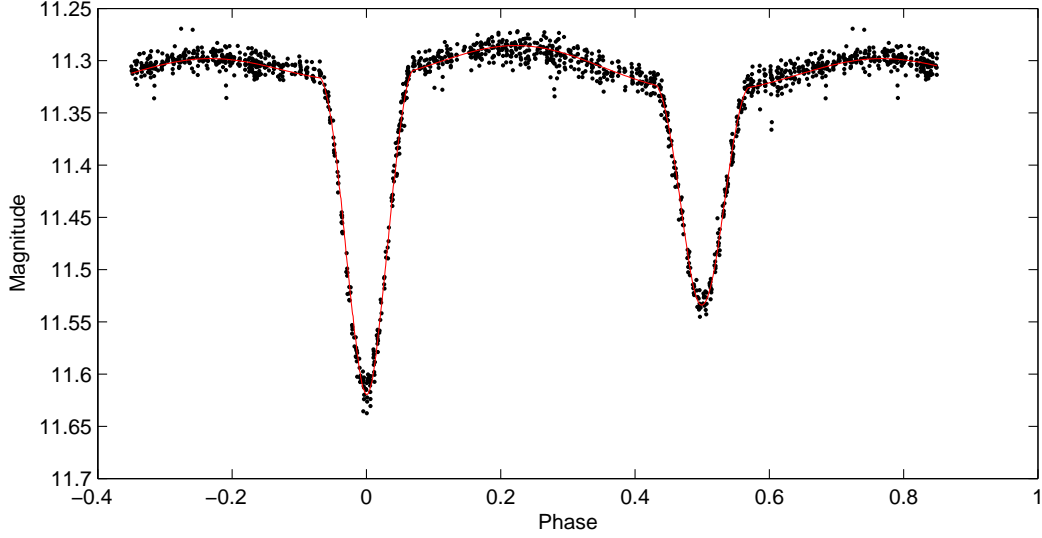


Fig. 1. Light curve analysis of V537 And, based on the Super WASP photometry.

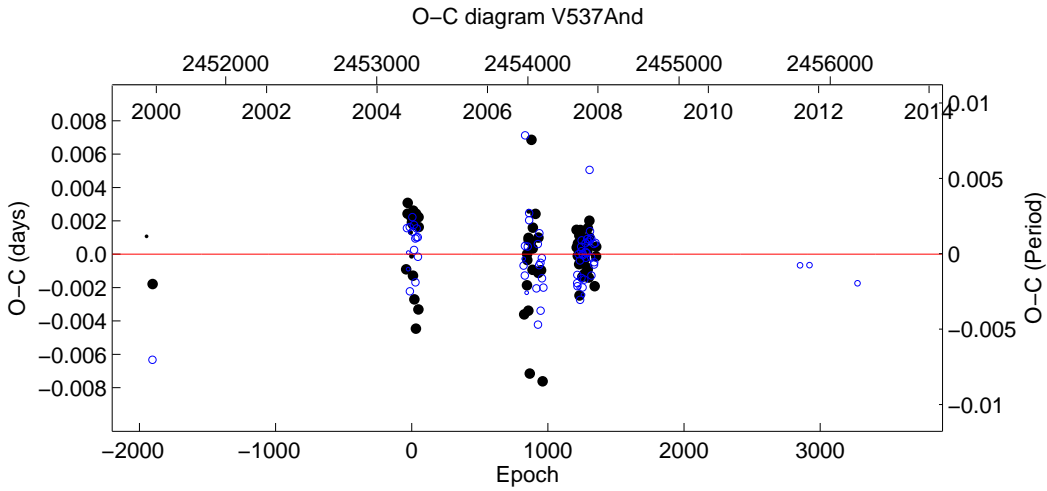


Fig. 2. O-C diagram of times of minima derived from available photometry for V537 And. The black points stand for the primary minima, while the blue open circles stand for the secondary ones. The larger the symbol, the higher the weight.

3.2 *GS Boo*

The star *GS Boo* (=GSC 02565-00667, $V=11.1$ mag) is also rather seldom-investigated system. It was discovered during the ROTSE survey (Akerlof et al., 2000), who presented incorrect period of 0.63 days, while the correct one is double, about 1.26 days. Later, only several papers with the minima observations were published. No light curve nor spectroscopic analysis were performed.

Therefore, we used the Super WASP photometry to analyse the LC of *GS Boo*. Despite a huge number of data points (more than 18000), we used only a small

Table 1

The light-curve parameters as derived from our analysis.

Parameter	V537 And	GS Boo	AM CrB	V1298 Her
$JD_0 - 2400000$	53231.6375 ± 0.0028	53128.4529 ± 0.0025	51242.8130 ± 0.0042	53726.4961 ± 0.0068
P [d]	0.9008483 ± 0.0000012	1.2568178 ± 0.0000017	0.7036534 ± 0.0000010	2.1446937 ± 0.0000030
q [10^{-10} d]	—	-36.0 ± 2.2	—	—
i [deg]	77.9 ± 1.2	76.9 ± 0.8	77.1 ± 1.8	83.6 ± 0.7
T_1 [K]	5900 (fixed)	6400 (fixed)	7000 (fixed)	6100 (fixed)
T_2 [K]	5310 ± 280	4410 ± 260	3810 ± 430	5410 ± 290
Ω_1	4.940 ± 0.019	5.683 ± 0.028	4.134 ± 0.013	7.102 ± 0.032
Ω_2	5.921 ± 0.021	4.748 ± 0.021	4.534 ± 0.020	10.671 ± 0.060
L_1 [%]	70.7 ± 1.1	85.4 ± 1.1	94.4 ± 1.2	80.6 ± 1.2
L_2 [%]	29.3 ± 0.9	14.6 ± 0.5	4.1 ± 0.7	18.7 ± 0.9
L_3 [%]	0.0 ± 0.0	0.0 ± 0.0	1.5 ± 0.6	0.7 ± 0.9
Spots:				
b_1 [deg]	13.7 ± 1.7	—	—	—
l_1 [deg]	330.0 ± 12.0	—	—	—
r_1 [deg]	13.2 ± 1.2	—	—	—
k_1	1.34 ± 0.05	—	—	—

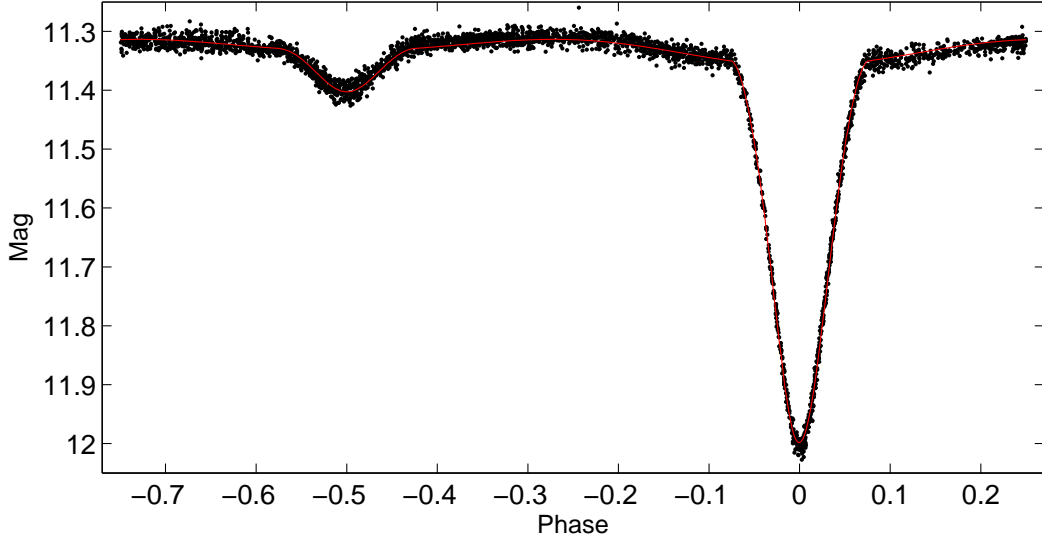


Fig. 3. Light curve analysis of GS Boo, based on the Super WASP photometry.

portion of these data for a LC analysis. The same situation as for V537 And also applies here, and Pickles & Depagne (2010) gave the only estimation about its spectral type. Hence, using an assumption of F6V component, we fixed the primary temperature to the value of 6400 K for the whole fitting process. The result of the light curve fit as provided by the PHOEBE program is plotted in Fig. 3, while the parameters are given in Table 1.

The results of the minima fitting to the whole photometric data set are given in Table 12. As one can see from the $O - C$ diagram given in Fig. 4, there is evident a long steady decrease of the orbital period, hence the quadratic term for the ephemerides was used (see the parabolic fit in Fig. 4). Despite the fact the very last two data points slightly deviate from the fit, any speculation about a possible third body is still rather premature yet.

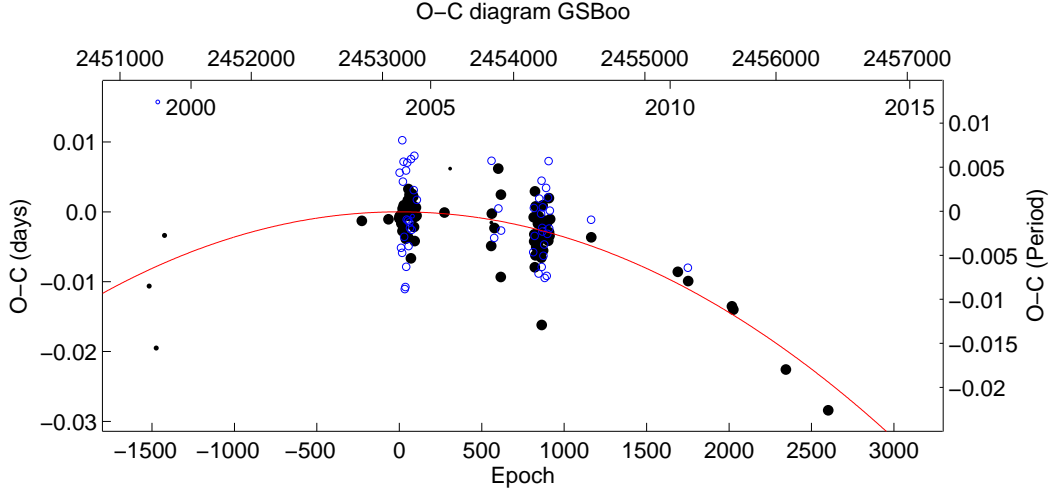


Fig. 4. O-C diagram of times of minima for GS Boo.

3.3 AM CrB

AM CrB (=GSC 02579-00069, $V=12.6$ mag) is an Algol-type eclipsing binary discovered during the ROTSE survey (Akerlof et al., 2000). They also gave its correct orbital period of about 0.7 days, but since then no other detailed analysis was performed.

Due to limited information about the system, the spectral estimation by Pickles & Depagne (2010) was used (F0III), fixing the value of the temperature to 7000 K for the whole LC analysis. The PHOEBE program provides us with a solution presented in Fig. 5, while the LC parameters are given in Table 1. As one can see, the secondary component is rather cooler and a bit smaller than the primary. A small fraction of the third light is on the lower limit what can be detected via this method and only further more detailed analysis of much more precise photometric data can confirm or refuse this hypothesis.

The $O - C$ diagram of the times of minima is plotted in Fig. 6, where the already published data points (11 observations) are plotted together with our new times of minima as derived from the Super WASP photometry (68 data points). The scatter of the new minima is rather large, but mainly the minima after the year 2010 show some variation, which can possibly be attributed to the third-body variation. New precise observations and minima timings during the upcoming years would be very useful for discussing this effect and its possible confirmation.

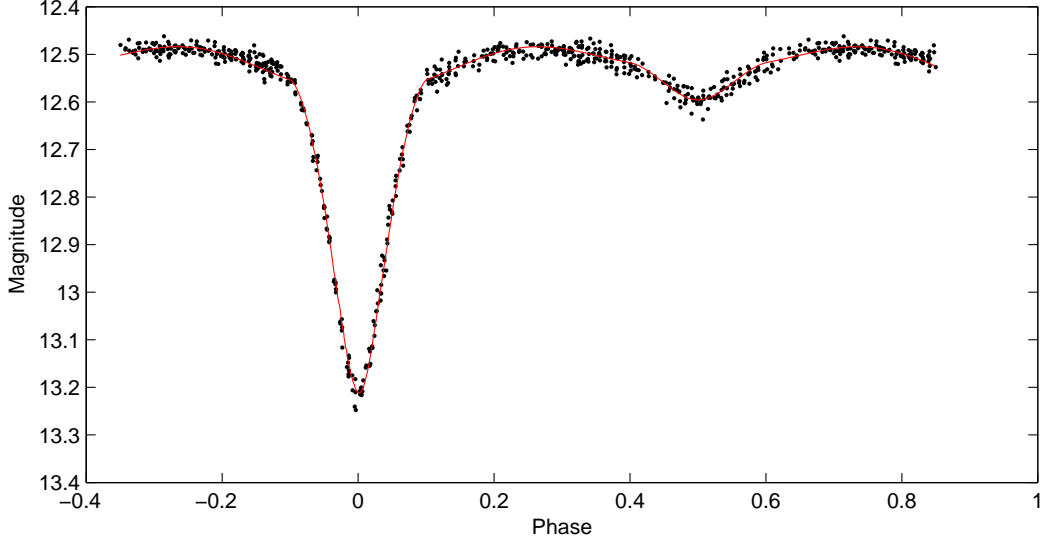


Fig. 5. Light curve analysis of AM CrB, based on the Super WASP photometry.

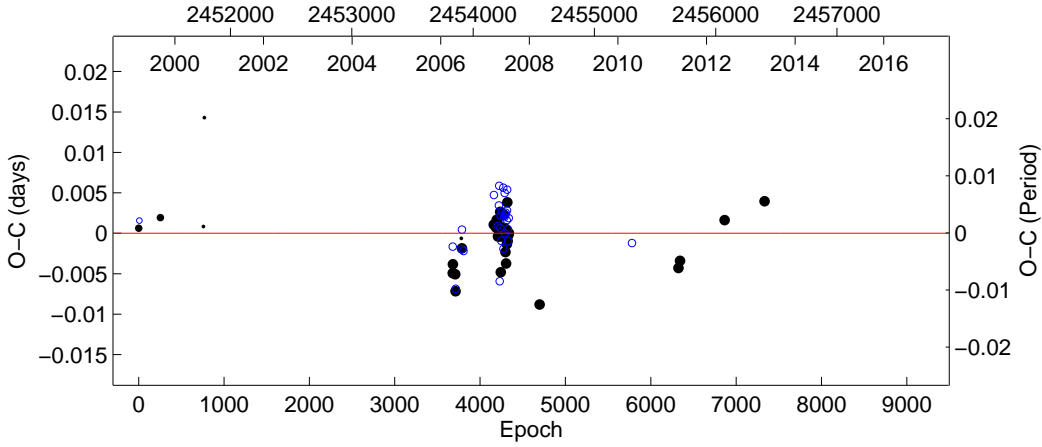


Fig. 6. O-C diagram of times of minima for AM CrB.

3.4 *V1298 Her*

The eclipsing binary system V1298 Her (=GSC 02077-00730, $V=9.8$ mag) is the brightest system in our sample. It was first mentioned as a variable by Norton et al. (2007), who also presented its correct orbital period of about 2.14 days. The spectral type was derived as F8 by Roeser & Bastian (1988). No other detailed analysis was performed.

The primary temperature was fixed at a value of 6100 K in agreement with its spectral type, and the LC solution was found with the PHOEBE program. The final fit is presented in Fig. 7, and the parameters of the LC solution are given in Table 1. However, as one can see from the LC in Fig. 7, the shape of the LC changes over the time interval and this intrinsic variability has certainly

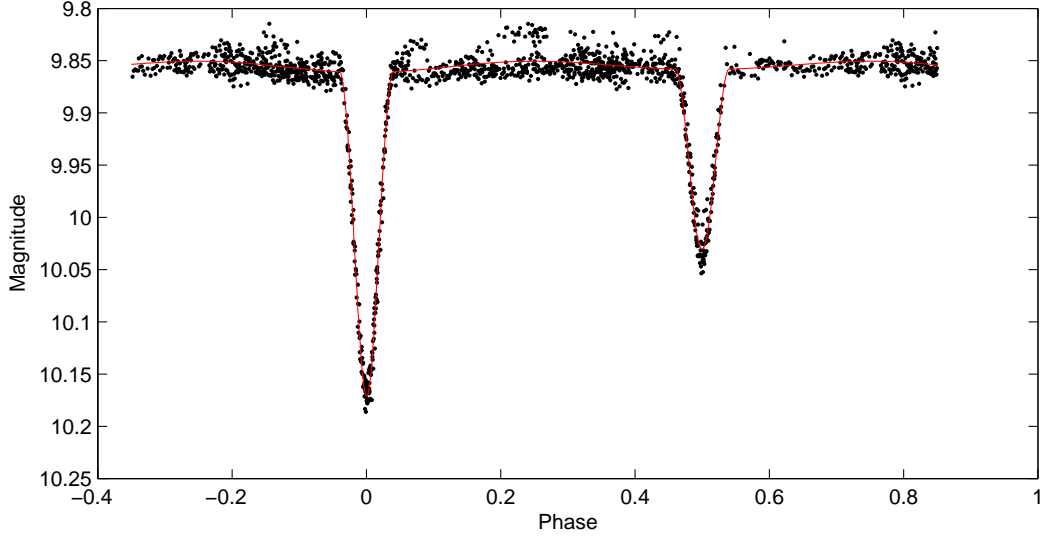


Fig. 7. Light curve analysis of V1298 Her, based on the Super WASP photometry.

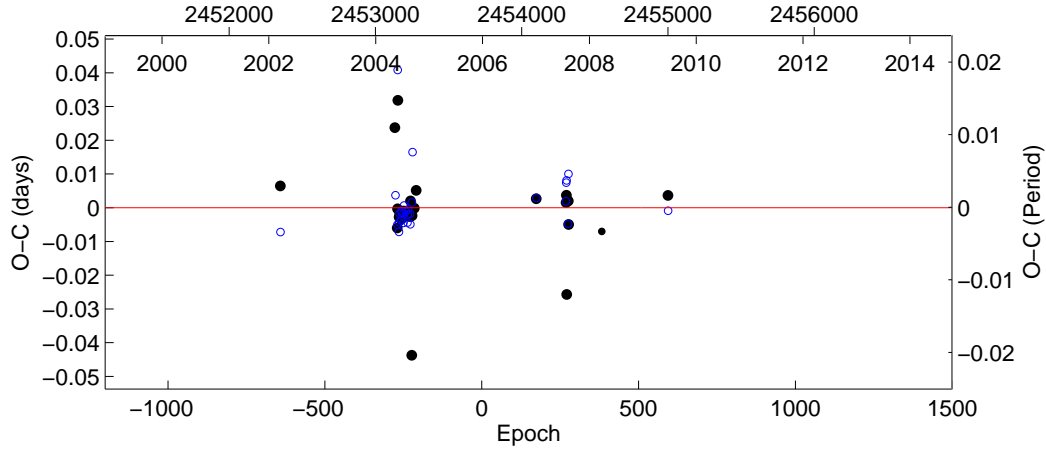


Fig. 8. O-C diagram of times of minima for V1298 Her.

some influence on the LC solution and precision of the LC parameters. Such variability is visible over many orbital revolutions of the binary in the Super WASP data, but its origin remains an open question.

The analysis of period of V1298 Her was based mainly on the Super WASP data, which yielded 62 times of minima (see Table 12 and the final $O - C$ diagram in Fig. 8). Together with a few data points derived from the ASAS photometry (Pojmanski, 2002), the time span covered with the minima times ranges over eight years. However, no variation is visible on these data points.

Table 2

The light-curve parameters as derived from our analysis.

Parameter	EL Lyn	FW Per	RU Tri	WW Tri
$JD_0 - 2400000$	55304.4386 ± 0.0022	54393.6419 ± 0.0036	53998.4392 ± 0.0066	53613.4883 ± 0.0056
P [d]	0.6445384 ± 0.0000011	0.7912319 ± 0.0000009	3.2685433 ± 0.0000050	1.7484409 ± 0.0000021
i [deg]	74.9 ± 0.6	89.9 ± 1.2	77.9 ± 1.2	85.1 ± 0.6
T_1 [K]	8800 (fixed)	6900 (fixed)	5600 (fixed)	7800 (fixed)
T_2 [K]	4920 ± 155	5060 ± 20	3980 ± 30	4700 ± 40
Ω_1	4.204 ± 0.025	4.392 ± 0.013	4.424 ± 0.074	5.436 ± 0.019
Ω_2	4.374 ± 0.072	4.760 ± 0.014	4.825 ± 0.057	7.612 ± 0.033
L_1 [%]	80.3 ± 2.5	81.0 ± 1.4	83.7 ± 0.9	93.9 ± 0.9
L_2 [%]	9.6 ± 0.8	18.9 ± 1.0	10.6 ± 1.4	6.1 ± 0.7
L_3 [%]	10.1 ± 1.7	0.1 ± 0.2	5.7 ± 1.2	0.0 ± 0.0

3.5 *EL Lyn*

EL Lyn (=GSC 02977-01179, V=12.6 mag) is another Algol-type eclipsing binary lacking of any detailed analysis. The star was discovered as a variable by Otero et al. (2005), who gave its correct orbital period of about 0.64 days, which makes it the shortest one in our sample. Later, only a few minima observations were published, but other information is missing.

Owing to having no information about its spectral type, only the photometric indices from the Tycho $B - V = 0.12$ mag, and $J - H = 0.358$ mag can be used to roughly estimate its type. Hence, we assumed the spectral type of about A2, therefore the temperature of $T_1 = 8800$ K was kept fixed for the whole LC analysis. The result of the LC fitting is plotted in Fig. 9, and the LC parameters are given in Table 2. As one can see, the secondary component is significantly cooler, but only mildly smaller than the primary. The level of the third light seems to be non-negligible and one can hope to find the third body evident in upcoming years during some more detailed photometric or spectroscopic analysis.

The period analysis was done using the already published data (18 times of minima), while six new data points were derived from the NSVS photometry and 104 from the Super WASP data. All of these minima are given in the Table 12 and the final $O - C$ diagram is plotted in Fig. 10. Regrettably, no additional variation is visible on the current data set and longer time span is needed to be covered with observations.

3.6 *FW Per*

The eclipsing system FW Per (=GSC 03341-00406, V=12.5 mag) is an Algol-type eclipsing binary discovered by Hoffmeister (1943). Despite its rather early discovery, the star was not analysed neither photometrically, nor spectroscopically, and only a few publications with the minima timings were published

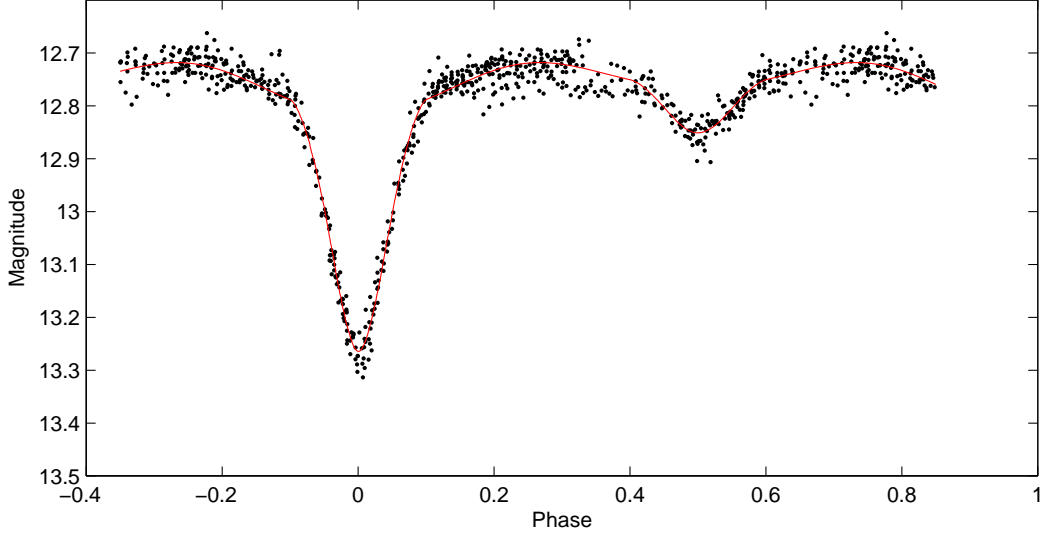


Fig. 9. Light curve analysis of EL Lyn, based on the Super WASP photometry.

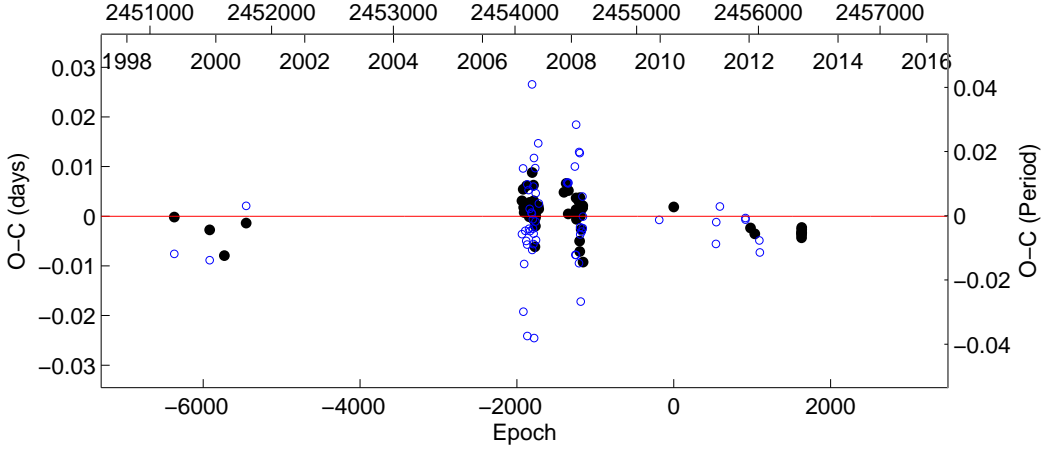


Fig. 10. O-C diagram of times of minima for EL Lyn.

to date. It is the northernmost star in our sample, has the orbital period of about 0.79 days, and shows rather deep eclipses.

Using the Super WASP photometry, we analysed the light curve of FW Per using the PHOEBE program. Owing to the fact that no spectral information is available, the photometric indices as derived from the 2MASS photometry (Skrutskie et al., 2006) indicate that the star should be earlier than F6, hence we fixed the primary temperature to the value of 6900 K for the whole LC fitting process. With this assumption the LC was fitted, the final plot is given in Fig. 11, and the parameters are written in Table 2.

The analysis of period was done using the already published minima times, as well as with those derived from the Super WASP data (36 new minima were derived). The final plot with the $O - C$ diagram is plotted in Fig. 12, while

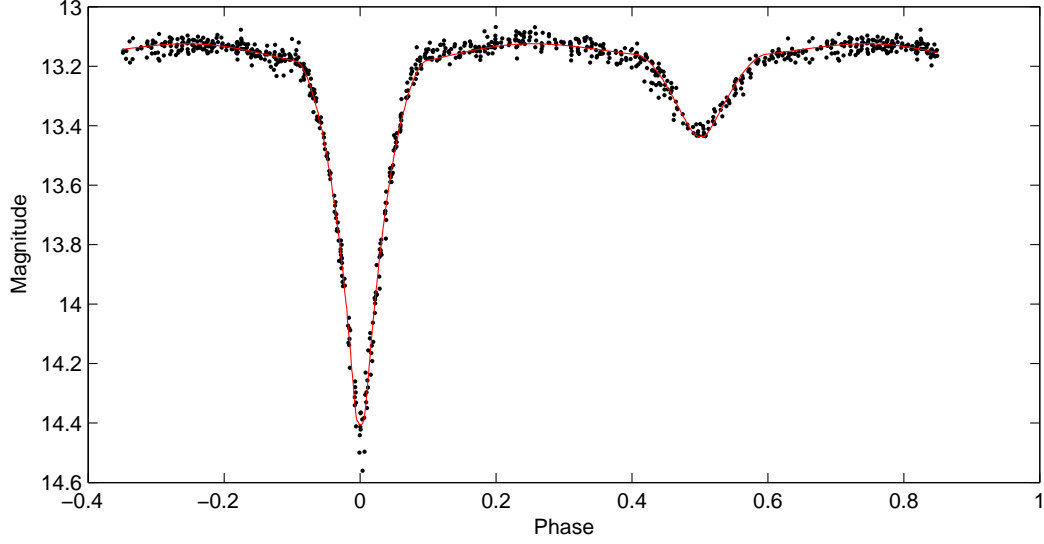


Fig. 11. Light curve analysis of FW Per, based on the Super WASP photometry.

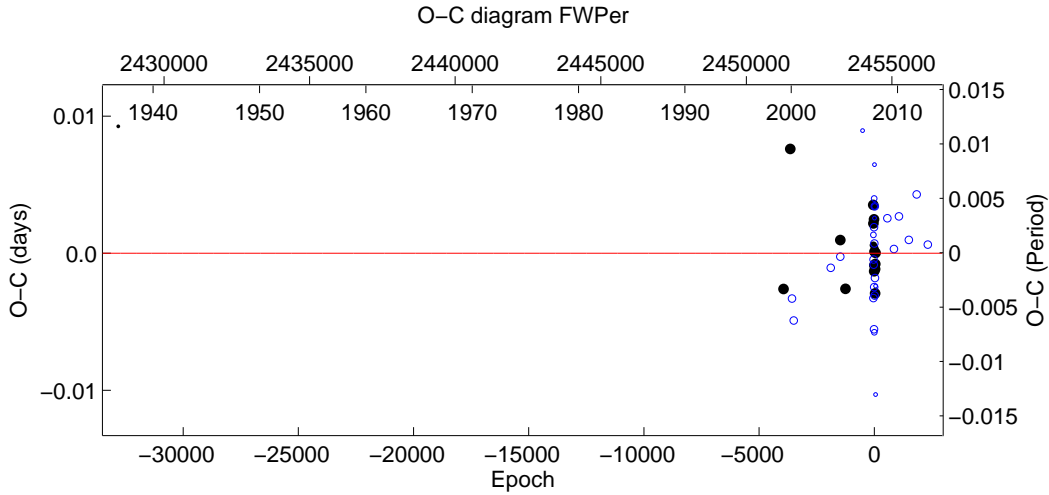


Fig. 12. O-C diagram of times of minima for FW Per.

no visible variation is evident on this plot.

3.7 *RU Tri*

The star RU Tri (=GSC 02316-00135, $V=11.1$ mag) was first mentioned as a variable by Strohmeier (1955). However, since then no detailed analysis was carried out. It has the orbital period of about 3.3 days and shows relatively deep minima of about 0.6 mag (V filter).

Using the Super WASP photometry, we analysed the LC of the system. The spectral type was presented as G0 by Malkov et al. (2006), however later

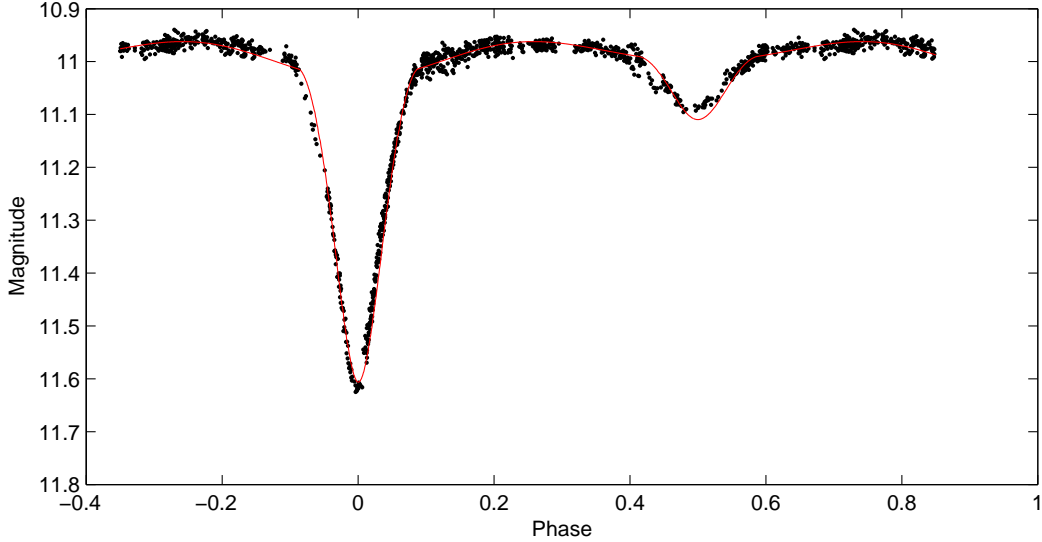


Fig. 13. Light curve analysis of RU Tri, based on the Super WASP photometry.

Pickles & Depagne (2010) gave G5V type. Hence, we use the latter value and fixed the primary temperature to the value of 5600 K. Moreover, Samus et al. (2012) noted also the close companion ($22''$ distant, 12 mag bright), but the Washington double star catalogue (Mason et al. , 2001) does not include any such information, hence its connection with the star RU Tri is doubtful. Therefore, a light contamination from the close component is expected due to the angular resolution of the Super WASP data (Butters et al., 2010). The final LC fit is presented in Fig. 13, while the parameters are given in Table 2. The third light value as resulted from the LC solution is surprisingly low for a close companion of such a brightness. We can only speculate that only a fraction of its light enters the aperture of the Super WASP telescope. Another problematic issue was some kind of additional intrinsic variability of the light curve as detected on the Super WASP data. Nature of these variations still remains an open question, but it surely influence the LC fit and its precision. If is this variation somehow connected with the close companion cannot easily be solved with the current data.

On the other hand, also the times of minima were derived from the Super WASP and NSVS data. These are stored in the Table 12, and the final $O - C$ plot is given in Fig. 14. Despite rather large scatter of the data points, due to poor coverage any variation is evident.

3.8 WW Tri

WW Tri (=TYC 2322-796-1, $V=12.1$ mag) is an Algol-type eclipsing binary discovered by Weber (1963). Its orbital period is of about 1.7 days, and shows

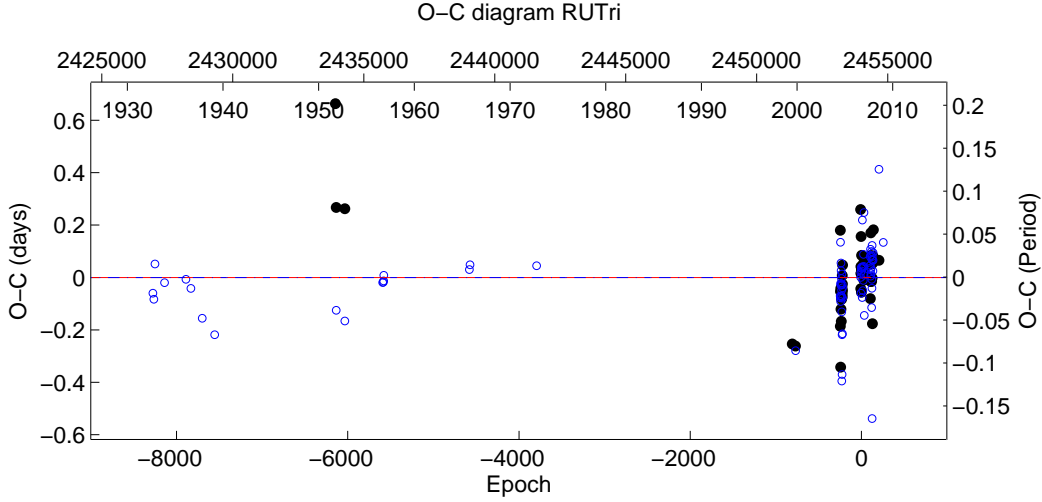


Fig. 14. O-C diagram of times of minima for RU Tri.

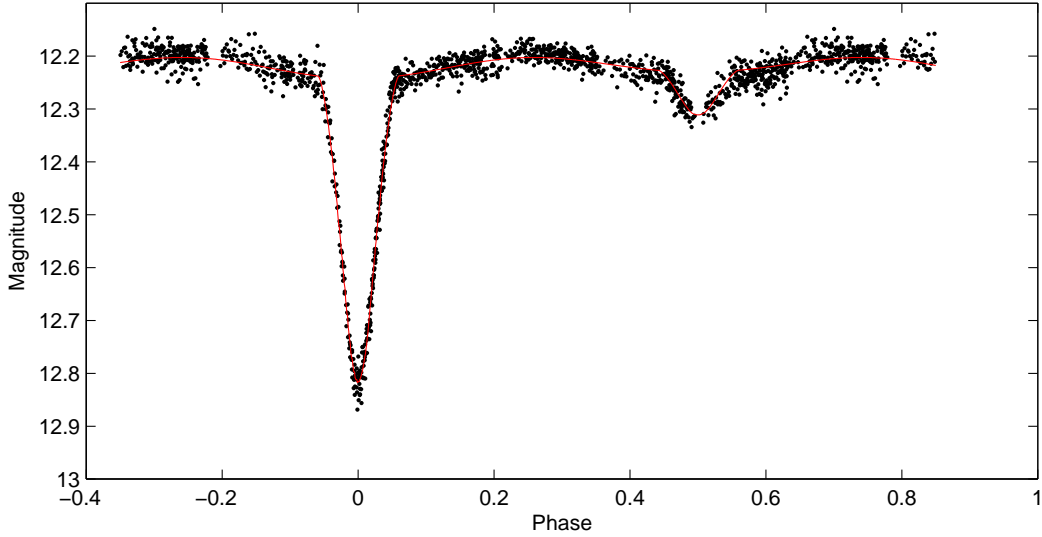


Fig. 15. Light curve analysis of WW Tri, based on the Super WASP photometry.

rather deep eclipses of about 0.6 mag. The spectral type was roughly estimated as A7V by Pickles & Depagne (2010), which is in good agreement with the *BVRI* observations by Skiff (2007). No detailed analysis of the star was performed.

Therefore, for the LC analysis the primary temperature of 7800 K was fixed. The Super WASP data were used for the LC fitting in the PHOEBE program. The final fit is presented in Fig. 15, and the parameters are given in Table 2. As one can see, the secondary is significantly cooler and smaller, hence also its contribution to the total luminosity of the system is only a few percent.

The analysis of the period was carried out with the already published data points (20 minima), together with our new data as derived from the Super

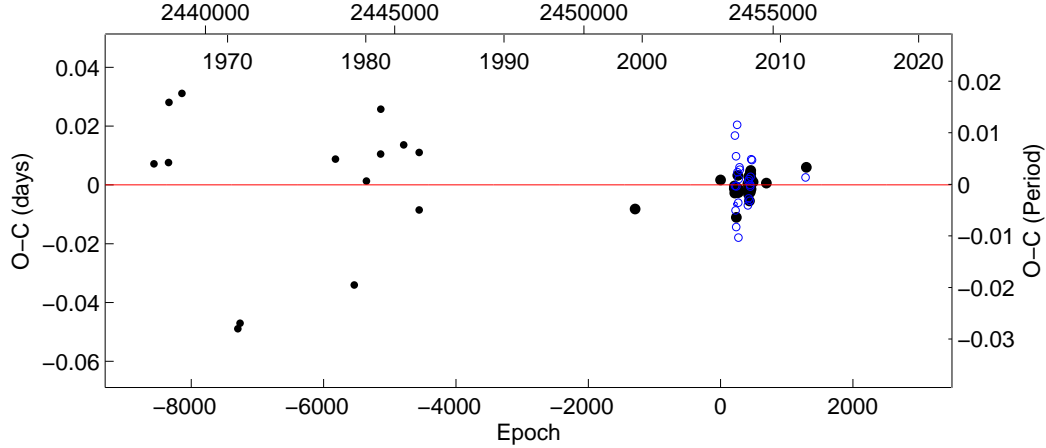


Fig. 16. O-C diagram of times of minima for WW Tri.

WASP (63 minima). The final $O - C$ diagram is plotted in Fig. 16, but any visible variation is evident in the present data set. More observations are needed during the next decades.

4 Discussion and conclusions

The first light curve analysis of eight Algol-type eclipsing binaries based on the Super WASP photometric data led to several interesting results:

- Confirming the well-known finding that for classical Algols the difference between the minima depths is in correlation with the temperature difference of the components.
- The surveys like Super WASP are suitable for this kind of analysis and the LC parameters as resulted from the analysis have only relatively small errors. Also the second-order effects like the third light contribution is detectable in these quality of data.
- The intrinsic variability is easily detectable in the Super WASP data due to the LC fitting and studying the residuals.
- Deriving the large set of minima timings for a prospective period analysis can be done relatively easily using the LC template.
- Using also some other surveys and the minima fitting procedure one can detect an additional variation in the $O - C$ diagram. But this method is more suitable for these systems, which have rather longer time span of observations for the third body perturbations to be discovered.

All of the presented systems are rather seldom-investigated and their follow-up observations using spectroscopy would be of great benefit. Especially those ones, where some indication of additional component in the system was found.

5 Acknowledgments

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Table 3

The heliocentric minima times used for the analysis.

Star	HJD	Error	Type	Filter	Source
	2400000+	[days]			
V537 And	53194.70023	0.00175	Prim	W	Super WASP
V537 And	53199.65736	0.00150	Sec	W	Super WASP
V537 And	53203.71204	0.00169	Prim	W	Super WASP
V537 And	53204.61354	0.00105	Prim	W	Super WASP
V537 And	53207.76254	0.01098	Sec	W	Super WASP
V537 And	53208.66439	0.01228	Sec	W	Super WASP
V537 And	53217.67441	0.00326	Sec	W	Super WASP
V537 And	53218.57141	0.00212	Sec	W	Super WASP
V537 And	53222.62876	0.01144	Prim	W	Super WASP
V537 And	53230.73497	0.01532	Prim	W	Super WASP
V537 And	53231.63810	0.00420	Prim	W	Super WASP
V537 And	53232.53868	0.00971	Prim	W	Super WASP
V537 And	53235.69198	0.00677	Sec	W	Super WASP
V537 And	53236.59196	0.00169	Sec	W	Super WASP
V537 And	53239.74230	0.00440	Prim	W	Super WASP
V537 And	53240.64621	0.00163	Prim	W	Super WASP
V537 And	53241.54789	0.00217	Prim	W	Super WASP
V537 And	53245.60086	0.00967	Sec	W	Super WASP
V537 And	53246.50021	0.00416	Sec	W	Super WASP
V537 And	53248.74937	0.00894	Prim	W	Super WASP
V537 And	53249.65494	0.00211	Prim	W	Super WASP
V537 And	53254.60853	0.00044	Sec	W	Super WASP
V537 And	53255.50675	0.00591	Sec	W	Super WASP
V537 And	53258.65695	0.00883	Prim	W	Super WASP
V537 And	53259.56442	0.00088	Prim	W	Super WASP
V537 And	53260.46554	0.00112	Prim	W	Super WASP
V537 And	53262.71624	0.00128	Sec	W	Super WASP
V537 And	53263.61763	0.00898	Sec	W	Super WASP
V537 And	53271.72474	0.00155	Sec	W	Super WASP
V537 And	53272.62442	0.00005	Sec	W	Super WASP
V537 And	53275.77423	0.00029	Prim	W	Super WASP
V537 And	53276.68062	0.00056	Prim	W	Super WASP
V537 And	53277.58088	0.00026	Prim	W	Super WASP
V537 And	53971.68278	0.00193	Sec	W	Super WASP
V537 And	53972.58404	0.01264	Sec	W	Super WASP
V537 And	53975.73368	0.00352	Prim	W	Super WASP
V537 And	53979.78983	0.00111	Sec	W	Super WASP
V537 And	53980.69245	0.00072	Sec	W	Super WASP
V537 And	53981.59993	0.00941	Sec	W	Super WASP
V537 And	53991.49984	0.02951	Sec	W	Super WASP
V537 And	53993.75241	0.00625	Prim	W	Super WASP
V537 And	53994.65512	0.00714	Prim	W	Super WASP
V537 And	53995.55562	0.00059	Prim	W	Super WASP
V537 And	53998.70940	0.00640	Sec	W	Super WASP
V537 And	54002.75938	0.00619	Prim	W	Super WASP
V537 And	54003.66459	0.00273	Prim	W	Super WASP
V537 And	54004.56530	0.00564	Prim	W	Super WASP
V537 And	54005.46788	0.01045	Prim	W	Super WASP
V537 And	54007.71947	0.00114	Sec	W	Super WASP
V537 And	54008.62074	0.00301	Sec	W	Super WASP
V537 And	54011.76409	0.00004	Prim	W	Super WASP
V537 And	54021.68135	0.00718	Prim	W	Super WASP
V537 And	54022.58291	0.01032	Prim	W	Super WASP
V537 And	54023.48914	0.00584	Prim	W	Super WASP
V537 And	54030.68815	0.00234	Prim	W	Super WASP
V537 And	54031.59027	0.00697	Prim	W	Super WASP
V537 And	54032.49237	0.00437	Prim	W	Super WASP
V537 And	54049.60784	0.01430	Prim	W	Super WASP
V537 And	54050.51017	0.00032	Prim	W	Super WASP
V537 And	54056.36123	0.00502	Sec	W	Super WASP
V537 And	54065.37238	0.00422	Sec	W	Super WASP
V537 And	54066.26839	0.00555	Sec	W	Super WASP
V537 And	54068.52362	0.00005	Prim	W	Super WASP
V537 And	54069.42659	0.00212	Prim	W	Super WASP
V537 And	54074.37961	0.00225	Sec	W	Super WASP
V537 And	54075.28237	0.00100	Sec	W	Super WASP
V537 And	54083.38823	0.00609	Sec	W	Super WASP
V537 And	54084.28621	0.00149	Sec	W	Super WASP
V537 And	54087.44161	0.00269	Prim	W	Super WASP
V537 And	54092.39702	0.00181	Sec	W	Super WASP
V537 And	54093.29664	0.00959	Sec	W	Super WASP
V537 And	54097.34430	0.00141	Prim	W	Super WASP

Table 4
The heliocentric minima times used for the analysis.

Star	HJD	Error	Type	Filter	Source
	2400000+	[days]			
V537 And	54102.30458	0.00212	Sec	W	Super WASP
V537 And	54321.66479	0.00186	Prim	W	Super WASP
V537 And	54322.56459	0.00434	Prim	W	Super WASP
V537 And	54325.71542	0.00349	Sec	W	Super WASP
V537 And	54326.61677	0.00220	Sec	W	Super WASP
V537 And	54327.51694	0.00426	Sec	W	Super WASP
V537 And	54329.77087	0.00488	Prim	W	Super WASP
V537 And	54330.67247	0.00479	Prim	W	Super WASP
V537 And	54331.57325	0.00102	Prim	W	Super WASP
V537 And	54334.72565	0.00015	Sec	W	Super WASP
V537 And	54335.62449	0.02744	Sec	W	Super WASP
V537 And	54338.77887	0.00587	Prim	W	Super WASP
V537 And	54339.68143	0.00212	Prim	W	Super WASP
V537 And	54340.58251	0.00035	Prim	W	Super WASP
V537 And	54341.47954	0.00026	Prim	W	Super WASP
V537 And	54344.63461	0.00904	Sec	W	Super WASP
V537 And	54345.53310	0.00282	Sec	W	Super WASP
V537 And	54347.78941	0.00184	Prim	W	Super WASP
V537 And	54348.68995	0.00125	Prim	W	Super WASP
V537 And	54349.59071	0.00127	Prim	W	Super WASP
V537 And	54350.49025	0.00276	Prim	W	Super WASP
V537 And	54352.74307	0.00207	Sec	W	Super WASP
V537 And	54353.64366	0.00020	Sec	W	Super WASP
V537 And	54354.54290	0.00458	Sec	W	Super WASP
V537 And	54355.44601	0.00091	Sec	W	Super WASP
V537 And	54357.69749	0.00217	Prim	W	Super WASP
V537 And	54358.59851	0.00046	Prim	W	Super WASP
V537 And	54359.49763	0.00551	Prim	W	Super WASP
V537 And	54361.74913	0.00474	Sec	W	Super WASP
V537 And	54362.65199	0.00035	Sec	W	Super WASP
V537 And	54363.55275	0.00354	Sec	W	Super WASP
V537 And	54364.45124	0.01015	Sec	W	Super WASP
V537 And	54368.50826	0.00014	Prim	W	Super WASP
V537 And	54373.46064	0.00022	Sec	W	Super WASP
V537 And	54374.81226	0.00594	Prim	W	Super WASP
V537 And	54377.51569	0.00154	Prim	W	Super WASP
V537 And	54381.57046	0.00550	Sec	W	Super WASP
V537 And	54382.47078	0.00923	Sec	W	Super WASP
V537 And	54383.37128	0.00360	Sec	W	Super WASP
V537 And	54387.42544	0.00681	Prim	W	Super WASP
V537 And	54389.67750	0.00493	Sec	W	Super WASP
V537 And	54392.38089	0.00061	Sec	W	Super WASP
V537 And	54393.73044	0.00079	Prim	W	Super WASP
V537 And	54394.63237	0.00109	Prim	W	Super WASP
V537 And	54395.53203	0.00002	Prim	W	Super WASP
V537 And	54396.43537	0.00060	Prim	W	Super WASP
V537 And	54398.68667	0.00837	Sec	W	Super WASP
V537 And	54402.73835	0.00916	Prim	W	Super WASP
V537 And	54405.44332	0.00075	Prim	W	Super WASP
V537 And	54406.34515	0.00137	Prim	W	Super WASP
V537 And	54407.69948	0.00271	Sec	W	Super WASP
V537 And	54409.49697	0.00412	Sec	W	Super WASP
V537 And	54410.39834	0.00181	Sec	W	Super WASP
V537 And	54418.50444	0.00290	Sec	W	Super WASP
V537 And	54419.40640	0.00200	Sec	W	Super WASP
V537 And	54420.30503	0.00286	Sec	W	Super WASP
V537 And	54436.52221	0.00005	Sec	W	Super WASP
V537 And	54437.42182	0.00344	Sec	W	Super WASP
V537 And	54438.32281	0.00249	Sec	W	Super WASP
V537 And	54441.47434	0.00321	Prim	W	Super WASP
V537 And	54446.43162	0.00219	Sec	W	Super WASP
V537 And	54450.48463	0.00172	Prim	W	Super WASP
V537 And	54452.28690	0.00025	Prim	W	Super WASP
GS Boo	53128.45198	0.00286	Prim	W	Super WASP
GS Boo	53129.70907	0.00620	Prim	W	Super WASP
GS Boo	53130.34375	0.00031	Sec	W	Super WASP
GS Boo	53138.50697	0.00091	Prim	W	Super WASP
GS Boo	53139.76383	0.00899	Prim	W	Super WASP
GS Boo	53141.64437	0.00308	Sec	W	Super WASP
GS Boo	53143.53306	0.00167	Prim	W	Super WASP
GS Boo	53150.44136	0.00020	Sec	W	Super WASP
GS Boo	53151.71432	0.00172	Sec	W	Super WASP

Table 5

The heliocentric minima times used for the analysis.

Star	HJD	Error	Type	Filter	Source
	2400000+	[days]			
GS Boo	53152.32972	0.00199	Prim	W	Super WASP
GS Boo	53153.58975	0.00113	Prim	W	Super WASP
GS Boo	53155.47883	0.00400	Sec	W	Super WASP
GS Boo	53157.35934	0.00207	Prim	W	Super WASP
GS Boo	53158.61436	0.00170	Prim	W	Super WASP
GS Boo	53160.50894	0.00095	Sec	W	Super WASP
GS Boo	53162.38794	0.00288	Prim	W	Super WASP
GS Boo	53163.64338	0.00374	Prim	W	Super WASP
GS Boo	53165.52548	0.00095	Sec	W	Super WASP
GS Boo	53167.41508	0.00139	Prim	W	Super WASP
GS Boo	53168.67196	0.00389	Prim	W	Super WASP
GS Boo	53170.54527	0.00011	Sec	W	Super WASP
GS Boo	53172.44206	0.00094	Prim	W	Super WASP
GS Boo	53175.57282	0.00119	Sec	W	Super WASP
GS Boo	53177.46497	0.00234	Prim	W	Super WASP
GS Boo	53179.35995	0.00161	Sec	W	Super WASP
GS Boo	53180.60300	0.00235	Sec	W	Super WASP
GS Boo	53182.49606	0.00068	Prim	W	Super WASP
GS Boo	53184.38022	0.00178	Sec	W	Super WASP
GS Boo	53189.41563	0.00647	Sec	W	Super WASP
GS Boo	53192.55230	0.00156	Prim	W	Super WASP
GS Boo	53194.43461	0.00027	Sec	W	Super WASP
GS Boo	53196.31742	0.00169	Prim	W	Super WASP
GS Boo	53197.58118	0.00257	Prim	W	Super WASP
GS Boo	53199.45823	0.00040	Sec	W	Super WASP
GS Boo	53201.34778	0.00272	Prim	W	Super WASP
GS Boo	53202.60508	0.00206	Prim	W	Super WASP
GS Boo	53204.48888	0.00313	Sec	W	Super WASP
GS Boo	53206.37807	0.00570	Prim	W	Super WASP
GS Boo	53209.51534	0.00265	Sec	W	Super WASP
GS Boo	53216.42352	0.00291	Prim	W	Super WASP
GS Boo	53218.32295	0.00021	Sec	W	Super WASP
GS Boo	53221.45837	0.00261	Prim	W	Super WASP
GS Boo	53223.34009	0.00030	Sec	W	Super WASP
GS Boo	53226.48729	0.00122	Prim	W	Super WASP
GS Boo	53228.36932	0.01442	Sec	W	Super WASP
GS Boo	53231.51291	0.00578	Prim	W	Super WASP
GS Boo	53235.28464	0.00751	Prim	W	Super WASP
GS Boo	53238.42759	0.00182	Sec	W	Super WASP
GS Boo	53240.30754	0.00720	Prim	W	Super WASP
GS Boo	53243.45978	0.00091	Sec	W	Super WASP
GS Boo	53245.33280	0.00651	Prim	W	Super WASP
GS Boo	53250.36355	0.00581	Prim	W	Super WASP
GS Boo	53255.39214	0.00808	Prim	W	Super WASP
GS Boo	53260.41825	0.00511	Prim	W	Super WASP
GS Boo	53262.30575	0.00732	Sec	W	Super WASP
GS Boo	53828.49555	0.00060	Prim	W	Super WASP
GS Boo	53829.75572	0.01078	Prim	W	Super WASP
GS Boo	53831.64979	0.00094	Sec	W	Super WASP
GS Boo	53833.52745	0.00106	Prim	W	Super WASP
GS Boo	53851.74783	0.00285	Sec	W	Super WASP
GS Boo	53853.63448	0.00215	Prim	W	Super WASP
GS Boo	53882.54979	0.00306	Prim	W	Super WASP
GS Boo	53884.42932	0.00204	Sec	W	Super WASP
GS Boo	53901.38656	0.00007	Prim	W	Super WASP
GS Boo	53902.65515	0.00116	Prim	W	Super WASP
GS Boo	53904.53523	0.00287	Sec	W	Super WASP
GS Boo	54149.61162	0.00385	Sec	W	Super WASP
GS Boo	54152.75865	0.00102	Prim	W	Super WASP
GS Boo	54154.64521	0.00061	Sec	W	Super WASP
GS Boo	54156.52567	0.00070	Prim	W	Super WASP
GS Boo	54157.78347	0.00395	Prim	W	Super WASP
GS Boo	54159.66850	0.00063	Sec	W	Super WASP
GS Boo	54161.54922	0.00087	Prim	W	Super WASP
GS Boo	54162.81691	0.00038	Prim	W	Super WASP
GS Boo	54166.57820	0.00189	Prim	W	Super WASP
GS Boo	54167.84202	0.00112	Prim	W	Super WASP
GS Boo	54171.60667	0.00202	Prim	W	Super WASP
GS Boo	54189.82673	0.00562	Sec	W	Super WASP
GS Boo	54190.45964	0.00062	Prim	W	Super WASP
GS Boo	54191.72017	0.00072	Prim	W	Super WASP
GS Boo	54194.86473	0.00026	Sec	W	Super WASP

Table 6

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
GS Boo	54195.48584	0.00264	Prim	W	Super WASP
GS Boo	54206.79959	0.00662	Prim	W	Super WASP
GS Boo	54208.68754	0.00323	Sec	W	Super WASP
GS Boo	54210.57153	0.00022	Prim	W	Super WASP
GS Boo	54211.82330	0.00115	Prim	W	Super WASP
GS Boo	54212.46273	0.00095	Sec	W	Super WASP
GS Boo	54213.70720	0.00279	Sec	W	Super WASP
GS Boo	54214.32732	0.00288	Prim	W	Super WASP
GS Boo	54215.59876	0.00023	Prim	W	Super WASP
GS Boo	54217.48326	0.00192	Sec	W	Super WASP
GS Boo	54218.73955	0.00687	Sec	W	Super WASP
GS Boo	54219.36946	0.00411	Prim	W	Super WASP
GS Boo	54220.62854	0.00111	Prim	W	Super WASP
GS Boo	54222.51347	0.00003	Sec	W	Super WASP
GS Boo	54224.39252	0.00230	Prim	W	Super WASP
GS Boo	54225.65122	0.00134	Prim	W	Super WASP
GS Boo	54227.53380	0.00146	Sec	W	Super WASP
GS Boo	54230.67875	0.00085	Prim	W	Super WASP
GS Boo	54232.56269	0.00281	Sec	W	Super WASP
GS Boo	54234.45133	0.00048	Prim	W	Super WASP
GS Boo	54235.70629	0.00180	Prim	W	Super WASP
GS Boo	54236.32835	0.00036	Sec	W	Super WASP
GS Boo	54247.65260	0.00174	Sec	W	Super WASP
GS Boo	54249.53068	0.00052	Prim	W	Super WASP
GS Boo	54252.66729	0.00221	Sec	W	Super WASP
GS Boo	54254.56009	0.00035	Prim	W	Super WASP
GS Boo	54256.44375	0.00060	Sec	W	Super WASP
GS Boo	54261.47622	0.00161	Sec	W	Super WASP
GS Boo	54264.61208	0.00264	Prim	W	Super WASP
GS Boo	54266.50871	0.00001	Sec	W	Super WASP
GS Boo	54268.38863	0.00106	Prim	W	Super WASP
GS Boo	54269.64056	0.00118	Prim	W	Super WASP
GS Boo	54271.52633	0.00145	Sec	W	Super WASP
GS Boo	54273.41052	0.00116	Prim	W	Super WASP
GS Boo	54276.55615	0.00126	Sec	W	Super WASP
GS Boo	54278.44018	0.00134	Prim	W	Super WASP
AM CrB	53831.54932	0.00154	Prim	W	Super WASP
AM CrB	53832.60808	0.00241	Sec	W	Super WASP
AM CrB	53833.66138	0.00029	Prim	W	Super WASP
AM CrB	53852.65880	0.00288	Prim	W	Super WASP
AM CrB	53855.47132	0.00015	Prim	W	Super WASP
AM CrB	53856.52710	0.00183	Sec	W	Super WASP
AM CrB	53902.62265	0.01162	Prim	W	Super WASP
AM CrB	53906.49139	0.00030	Sec	W	Super WASP
AM CrB	53907.54699	0.00010	Prim	W	Super WASP
AM CrB	53908.60478	0.00173	Sec	W	Super WASP
AM CrB	53920.56424	0.00416	Sec	W	Super WASP
AM CrB	54170.71639	0.00017	Prim	W	Super WASP
AM CrB	54171.77554	0.00240	Sec	W	Super WASP
AM CrB	54189.71467	0.00067	Prim	W	Super WASP
AM CrB	54194.64122	0.00084	Prim	W	Super WASP
AM CrB	54202.73251	0.00378	Sec	W	Super WASP
AM CrB	54204.49031	0.00535	Prim	W	Super WASP
AM CrB	54206.60272	0.00484	Prim	W	Super WASP
AM CrB	54208.71357	0.01308	Prim	W	Super WASP
AM CrB	54212.58616	0.00128	Sec	W	Super WASP
AM CrB	54213.63889	0.00601	Prim	W	Super WASP
AM CrB	54214.69954	0.00223	Sec	W	Super WASP
AM CrB	54215.74926	0.00091	Prim	W	Super WASP
AM CrB	54218.56419	0.00180	Prim	W	Super WASP
AM CrB	54219.61331	0.00069	Sec	W	Super WASP
AM CrB	54223.49200	0.00068	Prim	W	Super WASP
AM CrB	54224.54547	0.00358	Sec	W	Super WASP
AM CrB	54225.60040	0.00250	Prim	W	Super WASP
AM CrB	54226.65798	0.00365	Sec	W	Super WASP
AM CrB	54227.71087	0.00070	Prim	W	Super WASP
AM CrB	54228.41011	0.00129	Prim	W	Super WASP
AM CrB	54230.52634	0.00134	Prim	W	Super WASP
AM CrB	54231.58044	0.00324	Sec	W	Super WASP
AM CrB	54232.63747	0.00397	Prim	W	Super WASP
AM CrB	54235.45184	0.00093	Prim	W	Super WASP
AM CrB	54236.50965	0.00277	Sec	W	Super WASP

Table 7

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
AM CrB	54248.47469	0.00384	Sec	W	Super WASP
AM CrB	54249.52519	0.00076	Prim	W	Super WASP
AM CrB	54250.57809	0.00277	Sec	W	Super WASP
AM CrB	54251.63576	0.00106	Prim	W	Super WASP
AM CrB	54252.34144	0.00013	Prim	W	Super WASP
AM CrB	54254.45026	0.00112	Prim	W	Super WASP
AM CrB	54256.56119	0.00043	Prim	W	Super WASP
AM CrB	54257.61855	0.00349	Sec	W	Super WASP
AM CrB	54260.43616	0.00269	Sec	W	Super WASP
AM CrB	54261.48729	0.00562	Prim	W	Super WASP
AM CrB	54262.54214	0.00240	Sec	W	Super WASP
AM CrB	54263.59757	0.00405	Prim	W	Super WASP
AM CrB	54266.40990	0.00243	Prim	W	Super WASP
AM CrB	54267.47001	0.00227	Sec	W	Super WASP
AM CrB	54268.52289	0.00211	Prim	W	Super WASP
AM CrB	54269.58119	0.00126	Sec	W	Super WASP
AM CrB	54271.33406	0.00583	Prim	W	Super WASP
AM CrB	54273.44867	0.00163	Prim	W	Super WASP
AM CrB	54275.55920	0.01940	Prim	W	Super WASP
AM CrB	54276.61681	0.00270	Sec	W	Super WASP
AM CrB	54278.37299	0.00142	Prim	W	Super WASP
AM CrB	54279.43264	0.00330	Sec	W	Super WASP
AM CrB	54280.48561	0.00627	Prim	W	Super WASP
AM CrB	54281.54616	0.00214	Sec	W	Super WASP
AM CrB	54282.60009	0.00039	Prim	W	Super WASP
AM CrB	54285.40992	0.00243	Prim	W	Super WASP
AM CrB	54286.46686	0.00395	Sec	W	Super WASP
AM CrB	54287.52153	0.00044	Prim	W	Super WASP
AM CrB	54288.57634	0.00154	Sec	W	Super WASP
AM CrB	54292.44729	0.00534	Prim	W	Super WASP
AM CrB	54293.50477	0.00297	Sec	W	Super WASP
AM CrB	54294.55839	0.00730	Prim	W	Super WASP
V1298Her	52349.60925	0.00072	Prim	V	ASAS
V1298Her	52350.66793	0.00000	Sec	V	ASAS
V1298Her	54099.67548	0.00006	Prim	V	ASAS
V1298Her	54100.74810	0.00012	Sec	V	ASAS
V1298Her	55000.44782	0.00011	Prim	V	ASAS
V1298Her	55001.51566	0.00000	Sec	V	ASAS
V1298Her	53132.43972	0.00821	Prim	W	Super WASP
V1298Her	53137.78140	0.00749	Sec	W	Super WASP
V1298Her	53149.56755	0.00946	Prim	W	Super WASP
V1298Her	53150.64087	0.01306	Sec	W	Super WASP
V1298Her	53151.71789	0.00554	Prim	W	Super WASP
V1298Her	53152.83141	0.00921	Sec	W	Super WASP
V1298Her	53153.89475	0.01526	Prim	W	Super WASP
V1298Her	53161.36218	0.00428	Sec	W	Super WASP
V1298Her	53162.43893	0.00059	Prim	W	Super WASP
V1298Her	53163.50970	0.00777	Sec	W	Super WASP
V1298Her	53164.58376	0.00100	Prim	W	Super WASP
V1298Her	53165.65705	0.00184	Sec	W	Super WASP
V1298Her	53166.72965	0.04147	Prim	W	Super WASP
V1298Her	53176.37843	0.01542	Sec	W	Super WASP
V1298Her	53177.45113	0.00630	Prim	W	Super WASP
V1298Her	53178.52590	0.00352	Sec	W	Super WASP
V1298Her	53179.59646	0.00904	Prim	W	Super WASP
V1298Her	53180.67008	0.01254	Sec	W	Super WASP
V1298Her	53181.74281	0.00876	Prim	W	Super WASP
V1298Her	53191.39056	0.01317	Sec	W	Super WASP
V1298Her	53192.46644	0.00241	Prim	W	Super WASP
V1298Her	53193.53790	0.00556	Sec	W	Super WASP
V1298Her	53194.60945	0.01271	Prim	W	Super WASP
V1298Her	53195.68511	0.03609	Sec	W	Super WASP
V1298Her	53207.47841	0.01616	Prim	W	Super WASP
V1298Her	53208.55145	0.00536	Sec	W	Super WASP
V1298Her	53209.62310	0.01977	Prim	W	Super WASP
V1298Her	53219.27169	0.01504	Sec	W	Super WASP
V1298Her	53220.34611	0.00293	Prim	W	Super WASP
V1298Her	53221.41877	0.00269	Sec	W	Super WASP
V1298Her	53222.49105	0.00004	Prim	W	Super WASP
V1298Her	53223.56498	0.00247	Sec	W	Super WASP
V1298Her	53224.63669	0.00411	Prim	W	Super WASP
V1298Her	53235.35953	0.02042	Prim	W	Super WASP

Table 8

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
V1298Her	53236.43182	0.01652	Sec	W	Super WASP
V1298Her	53237.50335	0.00197	Prim	W	Super WASP
V1298Her	53238.57342	0.00756	Sec	W	Super WASP
V1298Her	53239.65267	0.00609	Prim	W	Super WASP
V1298Her	53248.18569	0.00724	Prim	W	Super WASP
V1298Her	53249.30336	0.03392	Sec	W	Super WASP
V1298Her	53250.37179	0.00106	Prim	W	Super WASP
V1298Her	53252.51878	0.00352	Prim	W	Super WASP
V1298Her	53253.60764	0.01005	Sec	W	Super WASP
V1298Her	53265.38684	0.00262	Prim	W	Super WASP
V1298Her	53278.26030	0.00586	Prim	W	Super WASP
V1298Her	54302.34831	0.00886	Sec	W	Super WASP
V1298Her	54303.42028	0.00712	Prim	W	Super WASP
V1298Her	54304.49853	0.02450	Sec	W	Super WASP
V1298Her	54305.56715	0.00277	Prim	W	Super WASP
V1298Her	54306.64390	0.00200	Sec	W	Super WASP
V1298Her	54307.68242	0.01522	Prim	W	Super WASP
V1298Her	54317.35447	0.00990	Sec	W	Super WASP
V1298Her	54318.43362	0.00114	Prim	W	Super WASP
V1298Her	54319.51394	0.00566	Sec	W	Super WASP
V1298Her	54320.57132	0.00269	Prim	W	Super WASP
EL Lyn	54056.61532	0.00146	Prim	W	Super WASP
EL Lyn	54057.57543	0.00244	Sec	W	Super WASP
EL Lyn	54066.61218	0.00172	Sec	W	Super WASP
EL Lyn	54067.57480	0.00051	Prim	W	Super WASP
EL Lyn	54068.51695	0.00312	Sec	W	Super WASP
EL Lyn	54070.79383	0.00042	Prim	W	Super WASP
EL Lyn	54074.66005	0.00310	Prim	W	Super WASP
EL Lyn	54075.61648	0.00219	Sec	W	Super WASP
EL Lyn	54083.68443	0.00139	Prim	W	Super WASP
EL Lyn	54084.64670	0.00136	Sec	W	Super WASP
EL Lyn	54085.61731	0.00036	Prim	W	Super WASP
EL Lyn	54091.73460	0.00281	Sec	W	Super WASP
EL Lyn	54092.70862	0.00016	Prim	W	Super WASP
EL Lyn	54094.64612	0.00228	Prim	W	Super WASP
EL Lyn	54099.46833	0.00126	Sec	W	Super WASP
EL Lyn	54099.79710	0.00225	Prim	W	Super WASP
EL Lyn	54100.44170	0.00151	Prim	W	Super WASP
EL Lyn	54100.76951	0.00288	Sec	W	Super WASP
EL Lyn	54101.38350	0.00299	Sec	W	Super WASP
EL Lyn	54101.73171	0.00568	Prim	W	Super WASP
EL Lyn	54109.46515	0.00122	Prim	W	Super WASP
EL Lyn	54111.72552	0.00320	Sec	W	Super WASP
EL Lyn	54114.62309	0.00238	Prim	W	Super WASP
EL Lyn	54115.58495	0.00250	Sec	W	Super WASP
EL Lyn	54116.55419	0.00194	Prim	W	Super WASP
EL Lyn	54118.48954	0.00134	Prim	W	Super WASP
EL Lyn	54120.42432	0.00344	Prim	W	Super WASP
EL Lyn	54120.74528	0.00292	Sec	W	Super WASP
EL Lyn	54121.71192	0.00166	Prim	W	Super WASP
EL Lyn	54122.67440	0.00290	Sec	W	Super WASP
EL Lyn	54123.64548	0.00225	Prim	W	Super WASP
EL Lyn	54135.56891	0.00282	Sec	W	Super WASP
EL Lyn	54136.53638	0.00155	Prim	W	Super WASP
EL Lyn	54139.43588	0.00243	Sec	W	Super WASP
EL Lyn	54140.40393	0.00094	Prim	W	Super WASP
EL Lyn	54140.75103	0.00391	Sec	W	Super WASP
EL Lyn	54141.36224	0.00348	Sec	W	Super WASP
EL Lyn	54141.70010	0.00107	Prim	W	Super WASP
EL Lyn	54143.62454	0.00036	Prim	W	Super WASP
EL Lyn	54145.56010	0.00092	Prim	W	Super WASP
EL Lyn	54146.52472	0.00228	Sec	W	Super WASP
EL Lyn	54147.49305	0.00415	Prim	W	Super WASP
EL Lyn	54148.45646	0.00189	Sec	W	Super WASP
EL Lyn	54149.42563	0.00116	Prim	W	Super WASP
EL Lyn	54150.39853	0.00022	Sec	W	Super WASP
EL Lyn	54151.36562	0.00105	Prim	W	Super WASP
EL Lyn	54152.32056	0.00255	Sec	W	Super WASP
EL Lyn	54153.29609	0.00203	Prim	W	Super WASP
EL Lyn	54153.61175	0.00290	Sec	W	Super WASP
EL Lyn	54154.58164	0.01362	Prim	W	Super WASP
EL Lyn	54155.56058	0.00472	Sec	W	Super WASP

Table 9

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
EL Lyn	54156.51633	0.00360	Prim	W	Super WASP
EL Lyn	54157.45795	0.00277	Sec	W	Super WASP
EL Lyn	54158.44848	0.00229	Prim	W	Super WASP
EL Lyn	54163.59946	0.00222	Prim	W	Super WASP
EL Lyn	54165.53879	0.00364	Prim	W	Super WASP
EL Lyn	54166.51572	0.00299	Sec	W	Super WASP
EL Lyn	54167.47085	0.00200	Prim	W	Super WASP
EL Lyn	54168.43858	0.00178	Sec	W	Super WASP
EL Lyn	54169.40648	0.00119	Prim	W	Super WASP
EL Lyn	54170.37788	0.00016	Sec	W	Super WASP
EL Lyn	54171.34093	0.00160	Prim	W	Super WASP
EL Lyn	54172.30206	0.00189	Sec	W	Super WASP
EL Lyn	54190.36862	0.00241	Sec	W	Super WASP
EL Lyn	54191.32279	0.00117	Prim	W	Super WASP
EL Lyn	54194.54490	0.00087	Prim	W	Super WASP
EL Lyn	54195.51283	0.00224	Sec	W	Super WASP
EL Lyn	54402.73419	0.00010	Prim	W	Super WASP
EL Lyn	54420.78304	0.00109	Prim	W	Super WASP
EL Lyn	54427.55084	0.00268	Sec	W	Super WASP
EL Lyn	54436.57425	0.00211	Sec	W	Super WASP
EL Lyn	54437.53491	0.00260	Prim	W	Super WASP
EL Lyn	54438.50800	0.00453	Sec	W	Super WASP
EL Lyn	54438.82868	0.00214	Prim	W	Super WASP
EL Lyn	54491.36341	0.00215	Sec	W	Super WASP
EL Lyn	54496.50194	0.00260	Sec	W	Super WASP
EL Lyn	54497.47729	0.00178	Prim	W	Super WASP
EL Lyn	54501.34507	0.00229	Prim	W	Super WASP
EL Lyn	54501.65819	0.00160	Sec	W	Super WASP
EL Lyn	54502.32899	0.00128	Sec	W	Super WASP
EL Lyn	54502.63651	0.00181	Prim	W	Super WASP
EL Lyn	54504.56581	0.00069	Prim	W	Super WASP
EL Lyn	54524.55013	0.00063	Prim	W	Super WASP
EL Lyn	54525.50449	0.00181	Sec	W	Super WASP
EL Lyn	54526.48215	0.00091	Prim	W	Super WASP
EL Lyn	54527.46049	0.00420	Sec	W	Super WASP
EL Lyn	54530.34297	0.00086	Prim	W	Super WASP
EL Lyn	54532.27449	0.00327	Prim	W	Super WASP
EL Lyn	54532.61658	0.00262	Sec	W	Super WASP
EL Lyn	54533.57442	0.00878	Prim	W	Super WASP
EL Lyn	54534.53527	0.00187	Sec	W	Super WASP
EL Lyn	54535.50625	0.00311	Prim	W	Super WASP
EL Lyn	54536.46742	0.00020	Sec	W	Super WASP
EL Lyn	54537.43795	0.00031	Prim	W	Super WASP
EL Lyn	54539.37258	0.00072	Prim	W	Super WASP
EL Lyn	54540.32113	0.00263	Sec	W	Super WASP
EL Lyn	54544.52516	0.00150	Prim	W	Super WASP
EL Lyn	54547.42513	0.00198	Sec	W	Super WASP
EL Lyn	54553.55305	0.00147	Prim	W	Super WASP
EL Lyn	54554.52214	0.00270	Sec	W	Super WASP
EL Lyn	54555.48669	0.00035	Prim	W	Super WASP
EL Lyn	54556.44937	0.00133	Sec	W	Super WASP
EL Lyn	54557.42070	0.00012	Prim	W	Super WASP
EL Lyn	54558.38533	0.00366	Sec	W	Super WASP
EL Lyn	54559.34297	0.00260	Prim	W	Super WASP
EL Lyn	51200.01770	0.00005	Prim	C	NSVS automat
EL Lyn	51200.33257	0.00042	Sec	C	NSVS automat
EL Lyn	51490.05740	0.00010	Prim	C	NSVS automat
EL Lyn	51490.37359	0.00046	Sec	C	NSVS automat
EL Lyn	51789.76917	0.00013	Prim	C	NSVS automat
EL Lyn	51790.09491	0.00046	Sec	C	NSVS automat
FW Per	53224.59647	0.00011	Sec	W	Super WASP
FW Per	53225.78453	0.00221	Prim	W	Super WASP
FW Per	53989.72696	0.00568	Sec	W	Super WASP
FW Per	54358.83124	0.00266	Prim	W	Super WASP
FW Per	54360.80252	0.00230	Sec	W	Super WASP
FW Per	54361.59836	0.00392	Sec	W	Super WASP
FW Per	54362.78605	0.00058	Prim	W	Super WASP
FW Per	54363.57569	0.00395	Prim	W	Super WASP
FW Per	54368.71766	0.00271	Sec	W	Super WASP
FW Per	54372.67343	0.00057	Sec	W	Super WASP
FW Per	54381.77352	0.00347	Prim	W	Super WASP
FW Per	54382.56715	0.00019	Prim	W	Super WASP

Table 10

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
FW Per	54383.74596	0.00139	Sec	W	Super WASP
FW Per	54384.54465	0.00246	Sec	W	Super WASP
FW Per	54387.70520	0.00102	Sec	W	Super WASP
FW Per	54388.50291	0.00352	Sec	W	Super WASP
FW Per	54389.68444	0.00068	Prim	W	Super WASP
FW Per	54392.44930	0.00318	Sec	W	Super WASP
FW Per	54393.64103	0.00121	Prim	W	Super WASP
FW Per	54395.62070	0.00293	Sec	W	Super WASP
FW Per	54396.80708	0.00391	Prim	W	Super WASP
FW Per	54397.59820	0.00063	Prim	W	Super WASP
FW Per	54398.78748	0.00496	Sec	W	Super WASP
FW Per	54399.58262	0.00452	Sec	W	Super WASP
FW Per	54405.51062	0.00399	Prim	W	Super WASP
FW Per	54406.69415	0.00065	Sec	W	Super WASP
FW Per	54407.49189	0.00332	Sec	W	Super WASP
FW Per	54409.46692	0.00380	Prim	W	Super WASP
FW Per	54410.65683	0.00079	Sec	W	Super WASP
FW Per	54418.56392	0.00174	Sec	W	Super WASP
FW Per	54419.74964	0.00072	Prim	W	Super WASP
FW Per	54420.54265	0.00151	Prim	W	Super WASP
FW Per	54427.66410	0.00270	Prim	W	Super WASP
FW Per	54437.54498	0.00569	Sec	W	Super WASP
FW Per	54438.34413	0.00426	Sec	W	Super WASP
FW Per	54439.53340	0.00010	Prim	W	Super WASP
RU Tri	53182.86739	0.06257	Sec	W	Super WASP
RU Tri	53191.28894	0.02663	Prim	W	Super WASP
RU Tri	53192.66590	0.03353	Sec	W	Super WASP
RU Tri	53194.19126	0.01136	Prim	W	Super WASP
RU Tri	53199.41496	0.03131	Sec	W	Super WASP
RU Tri	53200.86170	0.02828	Prim	W	Super WASP
RU Tri	53202.45734	0.00919	Sec	W	Super WASP
RU Tri	53203.84114	0.03668	Prim	W	Super WASP
RU Tri	53205.79535	0.03721	Sec	W	Super WASP
RU Tri	53207.41032	0.01140	Prim	W	Super WASP
RU Tri	53209.05954	0.00946	Sec	W	Super WASP
RU Tri	53215.67814	0.01704	Sec	W	Super WASP
RU Tri	53217.13629	0.01032	Prim	W	Super WASP
RU Tri	53218.86226	0.02484	Sec	W	Super WASP
RU Tri	53220.46926	0.00479	Prim	W	Super WASP
RU Tri	53222.18595	0.00827	Sec	W	Super WASP
RU Tri	53228.62500	0.00386	Sec	W	Super WASP
RU Tri	53230.16404	0.01427	Prim	W	Super WASP
RU Tri	53231.89413	0.00785	Sec	W	Super WASP
RU Tri	53233.54367	0.00825	Prim	W	Super WASP
RU Tri	53235.23043	0.00245	Sec	W	Super WASP
RU Tri	53236.81996	0.00576	Prim	W	Super WASP
RU Tri	53238.45425	0.00013	Sec	W	Super WASP
RU Tri	53240.05401	0.00881	Prim	W	Super WASP
RU Tri	53241.69789	0.03176	Sec	W	Super WASP
RU Tri	53243.36114	0.00504	Prim	W	Super WASP
RU Tri	53244.64490	0.02119	Sec	W	Super WASP
RU Tri	53246.61448	0.00168	Prim	W	Super WASP
RU Tri	53248.17720	0.02218	Sec	W	Super WASP
RU Tri	53249.90527	0.01307	Prim	W	Super WASP
RU Tri	53254.85845	0.00476	Sec	W	Super WASP
RU Tri	53256.41568	0.00424	Prim	W	Super WASP
RU Tri	53257.89588	0.01185	Sec	W	Super WASP
RU Tri	53259.69492	0.00316	Prim	W	Super WASP
RU Tri	53261.01252	0.01408	Sec	W	Super WASP
RU Tri	53262.94218	0.00056	Prim	W	Super WASP
RU Tri	53264.62391	0.01202	Sec	W	Super WASP
RU Tri	53266.29333	0.00896	Prim	W	Super WASP
RU Tri	53269.50554	0.00236	Prim	W	Super WASP
RU Tri	53270.97366	0.01309	Sec	W	Super WASP
RU Tri	53272.79780	0.00272	Prim	W	Super WASP
RU Tri	53274.37801	0.00224	Sec	W	Super WASP
RU Tri	53276.13843	0.00779	Prim	W	Super WASP
RU Tri	53277.68627	0.01081	Sec	W	Super WASP
RU Tri	53969.28190	0.01058	Prim	W	Super WASP
RU Tri	53970.67635	0.04092	Sec	W	Super WASP
RU Tri	53972.24796	0.02442	Prim	W	Super WASP
RU Tri	53973.92565	0.02768	Sec	W	Super WASP

Table 11

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
RU Tri	53975.57432	0.02329	Prim	W	Super WASP
RU Tri	53978.86989	0.01711	Prim	W	Super WASP
RU Tri	53980.40233	0.01423	Sec	W	Super WASP
RU Tri	53982.25314	0.01465	Prim	W	Super WASP
RU Tri	53991.91971	0.00235	Prim	W	Super WASP
RU Tri	53993.57382	0.00048	Sec	W	Super WASP
RU Tri	53995.11407	0.00785	Prim	W	Super WASP
RU Tri	53998.46206	0.00304	Prim	W	Super WASP
RU Tri	54001.73797	0.02008	Prim	W	Super WASP
RU Tri	54003.36672	0.00550	Sec	W	Super WASP
RU Tri	54005.06091	0.01433	Prim	W	Super WASP
RU Tri	54006.64452	0.01744	Sec	W	Super WASP
RU Tri	54008.28368	0.00304	Prim	W	Super WASP
RU Tri	54011.52927	0.04792	Prim	W	Super WASP
RU Tri	54021.34572	0.00105	Prim	W	Super WASP
RU Tri	54022.99406	0.00269	Sec	W	Super WASP
RU Tri	54029.41386	0.00841	Sec	W	Super WASP
RU Tri	54031.15743	0.01135	Prim	W	Super WASP
RU Tri	54032.97793	0.01693	Sec	W	Super WASP
RU Tri	54049.05162	0.00223	Sec	W	Super WASP
RU Tri	54050.76747	0.00496	Prim	W	Super WASP
RU Tri	54057.31130	0.00531	Prim	W	Super WASP
RU Tri	54063.84039	0.00875	Prim	W	Super WASP
RU Tri	54065.48342	0.05588	Sec	W	Super WASP
RU Tri	54067.13162	0.01003	Prim	W	Super WASP
RU Tri	54068.70153	0.00648	Sec	W	Super WASP
RU Tri	54075.33813	0.01360	Sec	W	Super WASP
RU Tri	54076.90128	0.00155	Prim	W	Super WASP
RU Tri	54083.46500	0.00585	Prim	W	Super WASP
RU Tri	54085.09807	0.00409	Sec	W	Super WASP
RU Tri	54086.68006	0.01055	Prim	W	Super WASP
RU Tri	54091.60155	0.01689	Sec	W	Super WASP
RU Tri	54093.26639	0.00225	Prim	W	Super WASP
RU Tri	54095.10921	0.00585	Sec	W	Super WASP
RU Tri	54103.08744	0.01115	Prim	W	Super WASP
RU Tri	54104.52200	0.01342	Sec	W	Super WASP
RU Tri	54333.54472	0.01168	Sec	W	Super WASP
RU Tri	54335.01864	0.01250	Prim	W	Super WASP
RU Tri	54338.42762	0.00519	Prim	W	Super WASP
RU Tri	54340.04775	0.01094	Sec	W	Super WASP
RU Tri	54341.71969	0.05560	Prim	W	Super WASP
RU Tri	54344.95772	0.03088	Prim	W	Super WASP
RU Tri	54346.64691	0.01102	Sec	W	Super WASP
RU Tri	54348.15791	0.01283	Prim	W	Super WASP
RU Tri	54349.84391	0.00142	Sec	W	Super WASP
RU Tri	54351.50670	0.00434	Prim	W	Super WASP
RU Tri	54353.08118	0.00964	Sec	W	Super WASP
RU Tri	54354.78876	0.00322	Prim	W	Super WASP
RU Tri	54356.37478	0.00495	Sec	W	Super WASP
RU Tri	54358.14942	0.00409	Prim	W	Super WASP
RU Tri	54359.69758	0.00105	Sec	W	Super WASP
RU Tri	54361.33019	0.01173	Prim	W	Super WASP
RU Tri	54362.89616	0.00949	Sec	W	Super WASP
RU Tri	54374.38397	0.00576	Prim	W	Super WASP
RU Tri	54377.66886	0.00745	Prim	W	Super WASP
RU Tri	54382.59218	0.01100	Sec	W	Super WASP
RU Tri	54384.11220	0.00667	Prim	W	Super WASP
RU Tri	54387.46234	0.00023	Prim	W	Super WASP
RU Tri	54388.91536	0.00859	Sec	W	Super WASP
RU Tri	54392.29160	0.00642	Sec	W	Super WASP
RU Tri	54393.98469	0.00280	Prim	W	Super WASP
RU Tri	54395.63658	0.01055	Sec	W	Super WASP
RU Tri	54397.26731	0.00483	Prim	W	Super WASP
RU Tri	54398.79476	0.00677	Sec	W	Super WASP
RU Tri	54401.56600	0.01020	Sec	W	Super WASP
RU Tri	54405.49483	0.00323	Sec	W	Super WASP
RU Tri	54407.00493	0.00195	Prim	W	Super WASP
RU Tri	54408.72172	0.00583	Sec	W	Super WASP
RU Tri	54410.34511	0.00456	Prim	W	Super WASP
RU Tri	54416.63664	0.01275	Prim	W	Super WASP
RU Tri	54418.51404	0.00468	Sec	W	Super WASP
RU Tri	54420.15851	0.00553	Prim	W	Super WASP

Table 12

The heliocentric minima times used for the analysis.

Star	HJD 2400000+	Error [days]	Type	Filter	Source
RU Tri	54436.50605	0.00303	Prim	W	Super WASP
RU Tri	54438.08309	0.00911	Sec	W	Super WASP
RU Tri	54439.74973	0.00238	Prim	W	Super WASP
RU Tri	54441.42159	0.00748	Sec	W	Super WASP
RU Tri	54444.66103	0.01172	Sec	W	Super WASP
RU Tri	54446.29983	0.00812	Prim	W	Super WASP
RU Tri	54452.94884	0.00412	Prim	W	Super WASP
RU Tri	54668.55591	0.01363	Prim	W	Super WASP
RU Tri	54670.53753	0.03986	Sec	W	Super WASP
RU Tri	51481.39911	0.00415	Prim	C	NSVS
RU Tri	51483.01587	0.00762	Sec	C	NSVS
WW Tri	53973.66586	0.00073	Prim	W	Super WASP
WW Tri	53980.66053	0.00031	Prim	W	Super WASP
WW Tri	53987.65189	0.00124	Prim	W	Super WASP
WW Tri	53993.79096	0.00396	Sec	W	Super WASP
WW Tri	53994.64708	0.00018	Prim	W	Super WASP
WW Tri	53995.52227	0.00632	Sec	W	Super WASP
WW Tri	54001.64114	0.00312	Prim	W	Super WASP
WW Tri	54002.50987	0.01206	Sec	W	Super WASP
WW Tri	54007.75303	0.00245	Sec	W	Super WASP
WW Tri	54008.63523	0.00135	Prim	W	Super WASP
WW Tri	54021.75899	0.00408	Sec	W	Super WASP
WW Tri	54022.62185	0.00044	Prim	W	Super WASP
WW Tri	54023.48341	0.00301	Sec	W	Super WASP
WW Tri	54030.49092	0.00491	Sec	W	Super WASP
WW Tri	54031.35462	0.00356	Prim	W	Super WASP
WW Tri	54049.74473	0.00680	Sec	W	Super WASP
WW Tri	54050.59620	0.00064	Prim	W	Super WASP
WW Tri	54056.72241	0.00229	Sec	W	Super WASP
WW Tri	54057.59127	0.00697	Prim	W	Super WASP
WW Tri	54066.33773	0.00204	Prim	W	Super WASP
WW Tri	54077.69333	0.00594	Sec	W	Super WASP
WW Tri	54084.67524	0.00792	Sec	W	Super WASP
WW Tri	54085.56476	0.00125	Prim	W	Super WASP
WW Tri	54087.31380	0.00941	Prim	W	Super WASP
WW Tri	54092.55907	0.00209	Prim	W	Super WASP
WW Tri	54093.43732	0.00466	Sec	W	Super WASP
WW Tri	54094.30796	0.00203	Prim	W	Super WASP
WW Tri	54114.42264	0.00475	Sec	W	Super WASP
WW Tri	54115.28851	0.01844	Prim	W	Super WASP
WW Tri	54120.53272	0.01145	Prim	W	Super WASP
WW Tri	54121.41557	0.00750	Sec	W	Super WASP
WW Tri	54333.84212	0.01086	Prim	W	Super WASP
WW Tri	54334.71323	0.00928	Sec	W	Super WASP
WW Tri	54335.59473	0.00098	Prim	W	Super WASP
WW Tri	54340.83748	0.00827	Prim	W	Super WASP
WW Tri	54348.70896	0.00451	Sec	W	Super WASP
WW Tri	54349.57872	0.00002	Prim	W	Super WASP
WW Tri	54354.83006	0.00402	Prim	W	Super WASP
WW Tri	54355.69685	0.00249	Sec	W	Super WASP
WW Tri	54356.57459	0.00082	Prim	W	Super WASP
WW Tri	54361.82192	0.01521	Prim	W	Super WASP
WW Tri	54362.69720	0.00102	Sec	W	Super WASP
WW Tri	54363.56793	0.00184	Prim	W	Super WASP
WW Tri	54368.81602	0.00704	Prim	W	Super WASP
WW Tri	54377.55151	0.00161	Prim	W	Super WASP
WW Tri	54382.80485	0.00101	Prim	W	Super WASP
WW Tri	54383.67114	0.00168	Sec	W	Super WASP
WW Tri	54384.54927	0.00022	Prim	W	Super WASP
WW Tri	54389.79777	0.00839	Prim	W	Super WASP
WW Tri	54392.41878	0.00642	Sec	W	Super WASP
WW Tri	54393.29086	0.00497	Prim	W	Super WASP
WW Tri	54396.79393	0.00827	Prim	W	Super WASP
WW Tri	54397.66351	0.00325	Sec	W	Super WASP
WW Tri	54398.53579	0.00905	Prim	W	Super WASP
WW Tri	54405.53091	0.00056	Prim	W	Super WASP
WW Tri	54406.40903	0.00079	Sec	W	Super WASP
WW Tri	54407.28542	0.00865	Prim	W	Super WASP
WW Tri	54410.78111	0.00510	Prim	W	Super WASP
WW Tri	54419.51814	0.00349	Prim	W	Super WASP
WW Tri	54420.40253	0.00067	Sec	W	Super WASP
WW Tri	54421.27007	0.00789	Prim	W	Super WASP
WW Tri	54439.62705	0.03069	Sec	W	Super WASP
WW Tri	54441.38355	0.00253	Sec	W	Super WASP